Assessment of Zooplankton diversity in Devkhal Chaur, Samastipur

Synopsis

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Introduction

When we take a moment to observe the environment around us, we find a multitude of living and non -living things. These comprise a vast range of biotic and abiotic factors contributing to the complex panorama of our surroundings. Among those, the biotic components, comprises diverse life forms including flowers, plants, animals, fungi and microorganisms, collectively constitute biodiversity. From the towering trees in the forests, to the microscopic organisms in the soil, from the birds flying high in the sky to the fish swimming in the rivers, biodiversity surrounds us in its myriad forms, sustaining the ecosystem upon which we depend.

Generally, biodiversity is categorized in three types i.e. genetic diversity, species diversity and ecological diversity. However, some researches show strong relationship between species diversity and genetic diversity, that can be correlated as a result of process acting in parallel at two levels (Thébault & Loreau, 2006). Also, the biodiversity is classified into alpha and beta diversity on the scale at which diversity is measured. These terms were first introduced by Whittaker in 1960(Andermann et al., 2022). Alpha diversity provides insights into the species within a specific habitat(Enkhtur et al., 2021). Whereas, beta diversity help us to understand how species composition changes across landscape and can indicate habitat quality and sensitivity of species(Yao et al., 2023). These measures are significant for understanding the patterns of biodiversity within ecosystem and are essential for ecosystem management.

For the better functioning of ecosystem and the provision of ecological services to human societies the importance of biodiversity is widely recognized. Studies on simplified ecosystem, focusing on single trophic levels, have demonstrated that diversity enhances critical ecosystem processes such as primary productivity and nutrient retention. Moreover, biodiversity serves as

form of biological insurance, mitigating potential disruptions caused by environmental changes (Oliver et al., 2015).

Biodiversity provides essential ecosystem services such as clean air, clean water, and fertile soil which are vital for sustaining human life. Additionally, many of our key resources, including food, medicines, and raw materials, are derived from biodiversity. For instance, a diverse range of plants and animals contribute to agricultural productivity, provide ingredients for pharmaceutical and also offer material for construction and manufacturing. Because of this immense importance of biodiversity, it needs to be conserved, as many species are on the verge of extinction due to human activities.

Alongside traditional methods like seed banking, *in vitro* techniques can also be taken in consideration for conserving biodiversity. *In vitro* methods are effective for collection, propagation and cryopreservation of many species. For endangered species, in situ conservation is often preferred. With increasing extinction threats, it is crucial to prioritize species protection and employ methods to sustain ecological balance.

Wetlands are also among the most productive ecosystem on earth and play a significant role in ensuring the ecological sustainability of a region. Wetlands hold significance due to practical benefits derived from their functions, which have been demonstrated to be valuable to humans. Wetlands possess different functions and capable of lasting for extended periods. In contrast, contemporary agricultural and industrial/commercial practices tend to be unsustainable, depleting resources such as soil and fossil fuels, leading to their short-lived existence. The potential for long-term viability is hindered by unsustainable nature of modern agricultural and industrial /commercial activities characterized by practices such as soil degradation and reliance on fossil fuels. A significant implication of this is that once wetlands are destroyed

ecological service due to development, their vital functions and inherent worth are often lost irreversibly (Mitsch & Gosselink, 2000).

The importance of conserving wetland is increasing as these area continue to decrease on global scale (Yi et al., 2024). Global estimates suggest that wetland area span from 5.3 to 12.8 million square kilometers. Roughly half of these wetlands have been lost over time. However, through 1971 Ramsar Convention, 144 countries have collaborated to safeguard the most crucial remaining wetland (Zedler & Kercher, 2005). Moreover, wetlands serve as critical resting points for migrating birds and mammals, as well as breeding grounds for amphibians, birds and certain reptiles (Semlitsch, 2000).

Other than this, zooplankton are the significant inhabitants of freshwater wetlands, serving as key players in maintaining the health and balance of these unique ecosystem. Acting as the natural filters, they consume algae and organic matter, which help to keep the water clean and clear within wetland habitat. The presence of zooplanktons influence the dynamics of ecosystem (Bruce et al., 2006). Zooplankton serve as grazers for algae and bacteria, impacting their community population(Lehman & Sandgren, 1985; Mehner, 2009). Additionally, they contribute nitrogen and phosphorus to phytoplankton(Hudson et al., 1999; Hudson & Taylor, 1996) thereby participating in a complete cycle of nutrient recycling. They also play a critical role in enhancing the efficiency of the Biological Carbon Pump (BCP), which regulates atmospheric carbon dioxide levels (Kwon et al., 2009).

Zooplankton exert a significant influence on biomass stocks of other planktonic groups. Specifically, they can change the abundance of prey population through consumption and impact predator population as they are consumed, ultimately affecting fish biomass (Vanni, 2002). Their species are commonly utilized as feed for cultured fish. The provision of fish feed constitutes one of the major expenses in aquaculture (Lupatsch et al., 2001). They also serve

as indicators of environmental health. Changes in their abundance and diversity reflect changes in water quality and ecosystem condition. By monitoring zooplankton, we can assess the impact of human activities on aquatic environment (Jeppesen et al., 2011). Zooplankton can be divided into two primary groups depending on their developmental stage: meroplankton and holoplankton. Meroplankton consist of larvae that mature into diverse marine creatures such as worms, molluscs, crustaceans, coral, echinoderms, fishes, or insects. On the contrary, holoplankton remain in their planktonic form throughout their entire lifespan and encompass species such as pteropods, chaetognaths, larvaceans, siphonophores, and copepods.(*Zooplankton ~ MarineBio Conservation Society*, n.d.).

Zooplankton species such as Rotifers, Cladocerans, Copepods, and Ostracods, are commonly used as bioindicators to monitor the health and quality of aquatic ecosystem(*Zooplankton as Bioindicatorsof Trophic Status of Two Wetlands in Kashmir Himalaya - Google Search*, n.d.). By the term "bioindicator" we mean, plants, planktons, animals and microbes, which serve as living organism employed to assess the health of natural ecosystem within the environment. Their primary function involves environmental health and detecting biogeographic changes occurring in ecosystem(Parmar et al., 2016). For example, Lichens and Bryophytes are used as bioindicator for monitoring air quality and zooplankton to assess water quality. Zooplanktons are highly sensitive to change in their environment, making them an excellent indicator of water quality.

While, both wetlands and zooplanktons contribute to functioning of aquatic ecosystem, they are distinct element within these intricate system. In India, the varied topography and climatic regimes support and sustain diverse and unique wetland habitats. Indian ecosystem covers the whole range of ecosystem types found with few exceptions of bogs, fens and typical salt marshes. Healthy wetlands play a vital role, ensuring sustainable food production and access

to potable water availability. They are also necessary for India's rich biodiversity, including numerous unique species that rely on wetland habitat (Prasad et al., 2002).

The wetlands of international importance are declared as Ramsar sites under Ramsar Convention, an intergovernmental treaty adopted on 2nd February 1971, in Iranian city of Ramsar. It provides the framework for national action and international cooperation for Convention and wise use of wetland and their resources. With six wetlands covering an area of 192,973 ha, the government of India became a contracting/member party of Ramsar Convention on 1st February 1982 (Sarkar, 2011). As of now, January 2024, there are 80 recognized Ramsar site in India (source; Wikipedia). Out of which only one is located in Bihar, i.e. Kabartal/Kanwar Lake, Begusarai.

Kanwar lake is a remnant Oxbow Lake formed by meandering of Budhi Gandak River within upper Indo-gangetic biogeographic region. The lake harbours a diverse array of aquatic flora and fauna. Recognizing its significance, the area was designated a protected zone in 1986 under section 37 of Wildlife (protection) Act, 1972, and later declared a bird Sanctuary in 1989. Additionally, Kabartal wetland is identified as an Important Bird Area (IBA) (Bird Life International, 2005) (Ambastha et al., 2007).

Among the other major wetlands in Bihar is the Kusheshwar Asthan wetland. The Kusheshwar Asthan wetlands located in Koshi-Gandak Basin, cover 2,92,143 hectares, with an altitude of 49 m above sea level. This wetland experience a hot sub-humid climate with an annual rainfall of 1,025.1 mm (Guhathakurta et al., 2020). The wetland harbours a diverse population of migratory birds during winter season, in addition to resident fowl. Recognizing its significance as a habitat for water birds, the wetland was designated as a bird sanctuary in 1994 (Singh et al., 2022).

Baraila Jheel is another example of a major wetland in Bihar. In Vaishali district, Baraila Jheel wetland is located covering an area of 12.7 square kilometers and serves vital ecological functions. Due to its immense importance Government of Bihar declared it a sanctuary in 1997, later officially named Baraila Lake Salim Ali Jubba Sahni Bird Sanctuary in 2016. The wetland dries up in summer with vegetation replaced by grass and transforms back in wetland during monsoon. Supported by various water sources including the Gandak Canal, Baya River and Noon River, it hosts a diverse range of flora and fauna. It provides a habitat for various resident and migratory birds, fish, amphibians, and reptiles (Bharati, 2018).

Another underrated wetland in North Bihar is the Devkhal Chaur located in Samastipur district. While limited research has been conducted on Devkhal Chaur, it is understood that it is of paramount importance to local communities, as it serves as a diverse ecosystem supporting various fish, birds and zooplanktons. The wetland's condition included prolonged drying seasons resulting in decreased water level, silt mining activities, diminished fish populations, reduced number of migratory birds and potential impact on zooplankton population. Owing to the importance of Devkhal Chaur, this has caught the attention of wetland experts and has been included as a part of Indo-German collaborative project 'Wetland Management for Biodiversity and Climate Change' for overall holistic development of the wetland and adjoining area. The integrated management planning of Devkhal Chaur wetland has been stratified into 'Extent', 'Catchment & Hydrology', 'Habitat & Biodiversity' and 'Ecosystem services & Livelihood'.

This study has been taken up to contribute primary information about the Biodiversity of Devkhal Chaur which has not been explored yet. By examining the ecological dynamics of zooplanktons in Devkhal Chaur, we will try to collect valuable information about overall health of Devkhal Chaur.

Objectives:

- To assess the abundance, alpha and beta diversity and community structure of zooplankton population of Devkhal Chaur.
- To observe the distribution of zooplankton species in different zones of wetland and evaluate their potential use as bioindicator of wetland health.
- We will also try to understand, the relationship between zooplankton abundance and other ecological parameters, such as phytoplankton biomass and abundance of fish.

Method:

Water samples can be gathered from specified locations at regular intervals throughout various seasons over the course of year. Zooplankton qualitative sampling can be conducted using a plankton net with mesh size ranging from 65 to 75 micrometers. This involves sweeping the net through the vegetation in littoral zone and towing in through water in limnetic zone from a boat. Quantitative samples can be obtained by filtering 100 litres of water. The collected specimen can be delicately transferred to tubes and immobilized using 5 % formalin solution, then preserved in 5 % buffered formalin with few drops of Rose Bengal added to enhance visibility by coloring zooplankton(Datta, 2011). Detailed taxonomic identification can be carried out by using a microscope. Quantitative analysis of zooplanktons can be done using Sedgewick rafter cell under research microscope. The species belonging to each group will be noted and number of each species will be counted contributing to alpha and beta diversity of zooplanktons(Sharma & Tiwari, 2011).

Expected outcome:

This is an exploratory research and we expect descriptive information initially. However, seasonal fluctuation and annual change can be analysed later. Initially the study would involve the identification and enumeration of various zooplankton species inhabiting the lake and its

alpha and beta diversity. Through sampling, the abundance and distribution of these taxa would be quantified, providing insights into the composition of zooplankton community. The study will also reveal if things like water temperature or pollution affect the kind of zooplankton residing in lake. Furthermore, the study will examine how the diversity of zooplankton changes over time, such as from season to season or year to year, to identify any consistent patterns or trends. Ultimately, the result of this research will provide valuable knowledge about how freshwater ecosystem work and how to better protect them, helping to create effective strategies for conserving biodiversity in these crucial environments.

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